

Ag 890C
no. 23.

APR 2 1900

U. S. Department of Agriculture.

CIRCULAR No. 23—(Agros. 63).

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

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**PROGRESS OF EXPERIMENTS IN FORAGE CROPS AND RANGE
IMPROVEMENT AT ABILENE, TEX.**

[In a great many sections of the Southwest the natural ranges and pastures have been nearly or entirely destroyed by overstocking. The native grasses have died out through excessively close grazing, and their places have been taken by useless weeds and shrubs. Owners of what have heretofore been fine grazing properties have thus suffered great loss in being deprived of their pastures, and are now engaged in an effort to somewhat restore the former conditions, if possible.

The Division of Agrostology in 1898 commenced a three-years' experiment with a view to helping in this matter. A body of land 640 acres in extent, near Abilene, Tex., was kindly loaned by its owner, and the citizens of that town cheerfully assisted in the movement by having the property placed under fence, building water tanks, etc. Mr. H. L. Bentley, special field agent of the Division of Agrostology, was placed in charge, and has been carrying out the plan of experimentation devised by the Agrostologist of the Department.

This is Mr. Bentley's second report of progress of experiments in range improvement, the first one having been submitted and printed in December, 1898, as Circular No. 8, and entitled "Experiments in Range Improvements."—F. L. S.]

There have been many serious difficulties to contend with during the past season. In the first place the months of January and February, especially the latter, were very unfavorable for experimental work. In order to explain the conditions that prevailed here, a statement showing the protracted and extreme cold during the month of February is presented.

Table showing the dates during February, 1899, when the temperature was below the freezing point.

Date.	Degrees.	Date.	Degrees.
Feb. 1.....	21	Feb. 11.....	1
2.....	18	12.....	— 6
3.....	25	13.....	9
4.....	14	14.....	26
5.....	14	15.....	22
6.....	12	18.....	30
7.....	10	22.....	28
8.....	14	23.....	17
9.....	13	24.....	20
10.....	13	26.....	20

There were only eight days during the month when the temperature was above 32 degrees.

A large number of seeds were sown during the month of October, 1898, and others during the January following, but as a result of the extreme cold weather during February, everything that had come up was killed by March 1.

The month of January was very dry. The following table shows the precipitation during that month:

Date.	Inch.	Date.	Inch.
Jan. 4	0.06	Jan. 11	0.02
5 .....	.10	23 .....	.08
9 .....	.24	27 .....	.01

Total for the month, 0.51 inch.

During February there was only 0.01 inch of rain, which fell on the 4th, and during March there was only 0.04 inch, which fell on the 11th. The ground in the pastures was not in condition to be harrowed, and the grass garden could not be plowed and made ready to receive seeds until April. During that month the rainfall was about normal for the season. The following table shows the precipitation during this month:

Date.	Inch.	Date.	Inch.
Apr. 5	0.30	Apr. 20	0.38
6 .....	.56	21 .....	.30
15 .....	.78	22 .....	.40
16 .....	.24		

Total for the month, 2.96 inches.

The rain on April 5 and 6 put the pasture ground in fair condition for harrowing, and on April 10 that work was begun and continued, with some interruptions, until completed.

During the autumn of 1898 the 10 acres in the grass garden had been plowed deep with a turning plow. March 15 following, notwithstanding the dry weather, the ground was in fair condition; as a result of the freezing during February it was easily pulverized, but was very cold and contained but little moisture. However, in anticipation of rain, the work of seed planting was begun March 15 and continued through April until May 4. Many of the seeds planted in March did not germinate at all, which was most probably due to the fact that the ground was very cold and the vitality of the seed thereby destroyed. The seeds that did germinate made a very vigorous growth. The same conditions, however, that induced such growth also induced a corresponding growth of weeds. The grass garden was laid off in plots 20

feet wide, separated into subdivisions according to the quantities of seeds in hand. The plots and subdivisions were marked by rows of sorghum, as a rule, and the grass seeds were sown broadcast. It was impossible to use plows in fighting weeds, and the work of getting rid of them had to be done by hand. It was necessary for the weeders to be in the plots, and as the ground was very wet a portion of the grasses in the plots was also destroyed in the effort to get rid of the weeds, either by trampling or by being pulled up with the weeds. The rainfall during May aggregated 4.02 inches, much above normal. During June it aggregated 5.45 inches. During July there was a sudden falling off in precipitation, as shown by the following table.

Date.	Inch.	Date.	Inch.
July 1.....	0.52	July 17.....	0.20
2.....	.10	24.....	.56

Total for the month, 1.38 inches.

By the 1st of August everything in the station garden had begun to show the inevitable effect of the drought. Hot winds were blowing during all of July, and the succulent garden plants presented the appearance of having been scalded with hot water, and in some instances were killed. During August the rainfall was only normal, being 0.10 of an inch on the 16th. In September there was a fraction more, viz, 0.44 of an inch on the 7th. During the first twenty-five days of October there was a precipitation of only 0.01 inch, falling on the 16th.

In view of the hot winds and the protracted dry weather it is remarkable that anything in the garden survived. October 26 the first rainfall of any consequence since June 30 (when the precipitation was 2.09 inches) occurred; the precipitation was 2.89 inches. During November there were several rains, viz:

Date.	Inch.	Date.	Inch.
Nov. 1.....	0.18	Nov. 21.....	0.12
18.....	.06	29.....	.90
20.....	1.10		

Total for the month, 2.36 inches.

Of the plants in the garden, the several varieties of alfalfa, sulla, sainfoin, and hairy vetch greened out wonderfully, and have since then made vigorous growths, in spite of the frosts during the months of November and December. Following the slight rainfall of November 1, there was a killing frost (the first of the season) on the night of the 2d, and there was much freezing weather during the months of

November and December, as will appear by the following table, showing the dates when the temperature was as low as 32 degrees:

Date.	Degrees.	Date.	Degrees.
Nov. 3.....	28	Dec. 15.....	26
4.....	30	19.....	27
Dec. 4.....	32	20.....	28
5.....	29	21.....	32
14.....	26	22.....	32

In view of the extremes of heat and cold and dry and wet weather, it will be seen that there were serious difficulties to contend with during the season of 1899.

RANGE IMPROVEMENT.

METHODS EMPLOYED.

The section of 640 acres was divided into six pastures of 80 acres each, two of 40 acres each, one of 70 acres, and the remaining 10 acres were set apart for testing such grasses or forage plants as fairly promised to be of practical value in the semiarid regions of Texas.

The work as planned by the agrostologist in 1898 was as follows:

Pasture No. 1.—No treatment except to keep stock off until June 1, pasturing the balance of the season.

Pasture No. 2.—Cut with a disk harrow and kept stock off until June 1, pasturing the balance of the season.

Pastures Nos. 3 and 4 (of 40 acres each).—Grazed alternately, the stock being changed from one pasture to another every two weeks, thus allowing the grasses a short period for recovery after each grazing.

Pasture No. 5.—No treatment except pasturing until June 1 and keeping stock off the balance of the season.

Pasture No. 6.—Left as a check, without any treatment whatever except to keep stock off during the first season.

Pasture No. 7.—Dragged with an ordinary straight-toothed harrow and stock kept off during the first season.

Pasture No. 8.—Disked and stock kept off during the first season.

The 70-acre pasture, No. 9, was not grazed. Seeds of a number of wild and cultivated varieties were sown directly upon the sod.

Three of the most experienced stockmen of Texas personally inspected every acre of the section March 23, 1898, and unanimously reported that its utmost capacity for supporting cattle at that time was 1 head of mixed stock to every 16 acres, or 40 head to the section. The rainfall during 1898 was exceptionally light, and practically nothing was accomplished that year on the station except the cultivation of the native sod—that is to say, a disk harrow was used in two of the 80-acre pastures to cut up the sod as thoroughly as practicable. An ordinary iron-tooth harrow was used on one 80-acre pasture, and the surface of

the land was scarified as thoroughly as was possible under the circumstances. There is a rather heavy growth of mesquite trees growing in each of the pastures, and on account of them it was not possible to scarify the surface of every acre.

The theory was, that by cutting the surface as deep as was practicable with the harrows (disk and tooth) the roots in the ground would be given better chance for development, the runners from the grasses would find soft ground in which to take root readily, the rain would sink into it instead of running off, and the seeds that fell would find a suitable place in which to germinate. In spite of the drought of

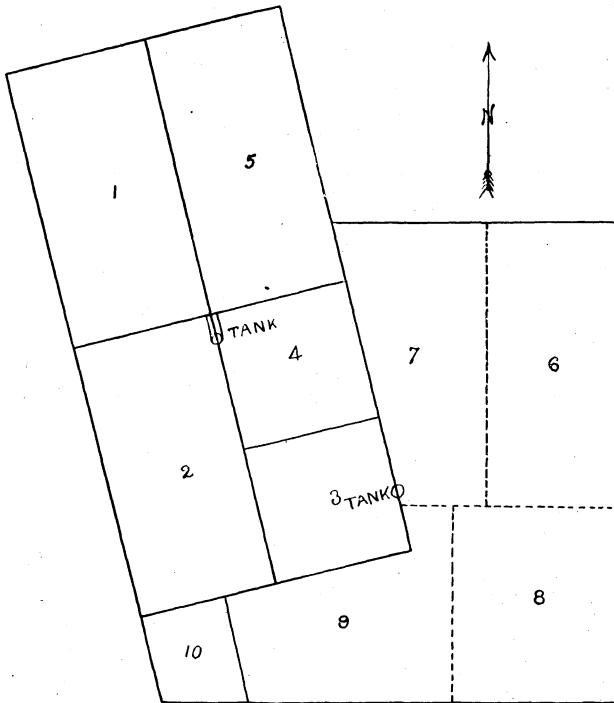


FIG. 1.—Plan of 640-acre tract used for the range experiments at Abilene, Tex. (Scale 3 inches to the mile.)

1898, during which there was less rainfall even than during the memorable dry year of 1887, there was a marked improvement in the range, treated as above mentioned. The harrowing was done during March and April, 1898, and, fortunately, the rainfall was reasonably good just after the work was completed and the autumn rains were nearly up to the normal, although the sum of precipitation for the season was very much below normal. A year from the first inspection, the same three stockmen made a second visit to the station and unanimously reported a very marked improvement over the conditions as they had found them in March, 1898. They reported in March, 1899, that the capacity of the

section to support stock was then 1 head of mixed cattle to 10 acres, or 64 head to the section. Later, in April, 1899, two of the men (Messrs. Middleton and Bryan) made another inspection of the pastures after the long spring rains had commenced falling, and reported that 1 head of mixed cattle to every 8 acres (80 head to the section) was the then capacity of the section. It is on this basis that cattle are now being held and will be held during the next year in the station pastures. This gain of 100 per cent in capacity to support stock is phenomenal, considering the drought of 1898, and had the pastures been stocked to their full capacity, as recommended by the inspectors, I would have taken the result as finally demonstrating the great value of cultivating the sod as explained above. But on account of the scarcity of water for stock in the pastures it was not possible to keep in them the proportion of animals contemplated, hence the pastures were rested for several months, and precisely at the season when the grass seeds were maturing and dropping. In determining, therefore, what factors entered into the experiment resulting in so marked an improvement in the range conditions, the fact of the resting of the pasture must not be overlooked. Indeed, I am satisfied that the improvement in the said range conditions has been due largely to this period of rest. My conclusions are: (1) That it will pay farmers and stockmen of Texas, especially in the semiarid districts of the State, to cultivate their pastures by use of disk and iron-tooth harrows; (2) that it will pay them to rest their pastures periodically during the seasons when the grass seeds are maturing and falling to the ground.

COST.

A farmer or stockman having his own teams and hands can do the work incident to these experiments when practically nothing else can be done on the farm or ranch, and at a nominal cost. The best time for such work is believed to be in the early spring, just before or just after rains. But it is quite probable that it will pay also to have similar work done in the autumn. The difficulty that is likely to be met with in making these experiments in the fall is that the rains at that season are not very regular in this section, and are generally followed by frosts; hence, it is quite possible that the damage caused by exposure of the grass roots, especially where the disk harrow is used, may more than offset the advantage that may be secured. The matter is worth testing and will be tried as soon as practicable.

CATCHING WIND-BLOWN SEEDS.

Another experiment has been instituted on one of the station pastures that promises to result favorably, namely, catching the grass seeds that are blown about by the winds.

The prevailing winds during the summer months in central Texas

are from the south. Many of the grass seeds, as they fall to the ground, except where the surface has been scarified or plowed, are blown by the winds onto other lands. In this way such seeds are often lost to the grounds on which they are grown and matured. In order to save these seeds to the pastures producing them, a part of one of the station pastures was selected, and about every 12 feet furrows have been plowed from east to west, the idea being, (1) that the seeds falling to the ground, if blown at all by the winds, will be caught in these furrows and in that way saved to the pastures, (2) that the storm waters falling on such pastures, instead of being allowed to waste by running off into creeks and bottoms, will also be caught in the furrows.

This work was done in May, 1899. By June 30 the furrows had caught a great many seeds, and, as the result of the surface irrigation incident to the rain having been collected in them, the grass immediately proximate to such furrows was much greener and more vigorous than that farther away. Indeed, in approaching the pasture so treated the furrows could easily be traced by the eye a half mile or more away by their fresh, green appearance.

TRANSPLANTING GRASS ROOTS.

Another experiment in the improvement of range conditions has been the transplanting of grass roots. There were considerable areas in the pastures of the station that were bare of all vegetation a year ago, the result of overstocking, drought, insects, and prairie dogs. Several native turf grasses were selected the past spring and the sods were taken up and planted in a few of these naked spots, just before rains. In every instance they have grown well and promise to cover the naked spots in a short time. The following grasses were used in this experiment: Curly mesquite (*Hilaria cenchroides*), needle grass (*Aristida fasciculata*), cotton-top (*Panicum lachnanthum*), wild timothy (*Muhlenbergia racemosa*), Galleta or black grama (*Hilaria mutica*), blue grama (*Bouteloua oligostachya*), side-oats grama (*Bouteloua curtipendula*), Canada rye grass (*Elymus canadensis*), and everlasting grass (*Eriochloa punctata*). All of these are natives of central Texas and occur in nearly every county. There are many other native grasses and forage plants here that may be used to good advantage in the same way.

GARDEN WORK.

In the 10 acres set apart for experiments with seed of grasses and forage plants the tests made this year have not been altogether satisfactory, chiefly owing to the dryness of the season, but results of practical value have been secured.

The soil is thin and dry, as a rule, and part of the ground is too rocky for cultivation. The bed of a small stream extends through the east side of the garden and drains the moisture from the lower lands; next to it is the dry soil, characteristic of the upland. The stream has

water in it only immediately after rains; it is a "dry branch" as understood in Texas. About 100 different varieties of seeds were received from the Division of Agrostology and they have been carefully tested, in many cases with satisfactory results.

SALTBUSHES.

Seeds of several varieties of saltbushes were planted, but only a few of them germinated. The plantings were made March 16 and April 18. The seed of Nelson's saltbush (*Atriplex pabularis*) came up, but only a few plants were saved. Of Nuttall's saltbush (*Atriplex nuttallii*) only a few vigorous plants were secured. About a dozen weak plants of the shad scale (*Atriplex canescens*) came up, but they soon died. Of all the varieties of saltbushes that were tested the annual saltbush from Australia (*Atriplex holocarpa*) gave the best result. The seeds were planted March 16 and April 18. A number of vigorous plants were secured, but most of them were destroyed in one night by a prairie dog that made its way into the grass garden through a woven wire fence. The two plots of saltbush planted were on thin land. The growth was not very vigorous, being only from 12 to 18 inches, but the seed development was surprisingly great. As a drought-resisting plant too much can not be said in its favor. Seed formed and matured in the long, hot, dry summer. Up to December 1 the bushes continued green, but by December 15 the plants were nearly dead. On each of the varieties except the shad scale there were many thousand seeds, and although twice in July and August they were carefully stripped of seed, the ground under each bush is now covered with hundreds of the seeds that have ripened and fallen off. It is said that the saltbush will mature several crops of seeds in a season, and this is not hard to believe considering the results of the tests in the station garden this year. It withstood the utmost extremes of drought. November 1, after four months of dry weather, with the hot winds which at that season prevail in this section and in all the western counties of Texas, when nearly everything else in the grass garden was showing the effects of the heat and the dry weather, the saltbush appeared nearly as vigorous as it did during the wet weather. The saltbushes are recommended especially for the sections of Texas in which the soils are impregnated with alkali. The annual saltbush is valuable; it is an excellent forage plant for soiling sheep and cattle, and horses will eat both the bush and the seed.

LEGUMES.

ALFALFA OR LUCERN.

Seeds of alfalfa (*Medicago sativa*) were sown in March, 1898, on the freshly broken sod. A rather thin stand was secured and when it had grown to about 6 or 10 inches in height, the long dry spell began and checked all further growth; indeed, it gradually dried up on its roots until scarcely a stem of it was to be seen. The following fall and win-

ter the prairie dogs and rabbits destroyed pretty nearly all the roots left by the drought. In the early spring of this year (1899) a few of the stems were noticed after the ground had been plowed, and they were carefully protected. Without other water than the natural rainfall the plants developed remarkably. By June 1 they had grown to be from 18 to 27 inches tall, at which time the crop was cut. On July 2 it was cut again, many of the stems measuring from 24 to 28 inches. July 22 a third crop was ready for cutting, some of the stems measuring from 18 to 20 inches in length. It is true the rainfall here from April 1 to July 1 had been above normal, but I am strongly inclined to believe that alfalfa will thrive in this section without irrigation. April 25, 1899, one pint of seed was procured and sown in a rather low but not at all wet plot of ground, affording an excellent stand. The growth continued to be vigorous up to about July 20, by which time the severe drought had set in. The foliage was dried and parched by August 1, and even the roots appeared to be dying. October 26 the drought was broken by a good rain, and by the 30th green leaves began to start from the roots. By the last of November the new foliage was from 8 to 10 inches in height. There were several white frosts and one or two freezes in November, but December 1 this plot was as green as in spring time, and the new growth was from 12 to 18 inches tall, and is even yet (December 30) green and vigorous looking.

TURKESTAN ALFALFA.

(*Medicago sativa turkestanica*.)

The seed of the Turkestan alfalfa was sown in April on rather thin dry land and only a partial stand was secured. It grew well until the drought set in, but soon began to show indications of injury. By August 1 the plants began to drop their leaves, and by September 1 the roots also appeared to be dead or dying. After the rains (October 26) the roots were slow to revive, but by November 15 they had put out a new growth. By December 1 this growth was from 11 to 12 inches tall, but less strong than the common alfalfa. At this date the plants are green and vigorous.

OASIS ALFALFA.

A small package of oasis alfalfa from Tunis was received through the Division of Agrostology. Three plantings were made, one in February, 1899, which, on account of the severe frosts that followed a day or two later, failed to germinate. In April one-half of the balance of the seed was sown in a low but not damp plot, and what was left was planted on higher land. Excellent stands were secured from each of these last two plantings. The growth was vigorous from the start, but by July 30 the plants were looking wilted and by August 1 the foliage had withered badly and the roots were apparently dead. I reported about that time that I feared the roots were all dead. The rain that fell October 26 quickly revived them; by November 5 fresh leaves

were putting out, and by November 15 the new growth was from 8 to 12 inches tall. On December 1 the growth was from 12 to 20 inches high and at this date (December 30) the plants are still green and vigorous. In approaching the station garden the vigorous growth of these plots can be distinctly noticed at a distance of half a mile. The results of the experiments with this particular variety of alfalfa are very gratifying and it seems likely to do well in this section without other moisture than a normal rainfall. To date, the oasis alfalfa is more satisfactory than the other varieties.

RED CLOVER.

Seeds of this variety were sown in two plats and good stands secured in each, one in low the other in higher land, both dry. The plantings were both made in April. In each case the growth was vigorous at the start, but on account of the early spring rains a very heavy growth of weeds resulted, that choked out many of the clover roots. In spite of this difficulty, by May 5 there was a vigorous growth from 8 to 16 inches high, that continued green through June and as late as July 20. By August 5 the hot, dry winds had very much injured the plants; by September 1 the foliage was withered, and soon even the roots were mostly dead.

WHITE CLOVER.

This variety failed to yield a good stand, and at no time during the year did it do as well as the red clover. The weeds got the start of it in the early spring, and when the drought set in the foliage soon withered, and by September 1 most of the roots were dead.

CRIMSON CLOVER.

The seed of this variety was sown in a low flat plot near a dry "branch." The early spring rains filled the branch and kept it full of water several weeks. A fair stand was secured, but the weeds soon injured it materially. Soon after the drought set in the plants began to languish, and by September 1 the roots were dead. The foliage turned yellow during the early spring rains, evidently the result of too much moisture.

MAMMOTH CLOVER.

This variety was also tried without obtaining a first-class stand and the weeds soon thinned that which was secured. The growth was never very vigorous and gave way entirely soon after the drought began.

BUR CLOVER.

(*Medicago denticulata*.)

Only a few seeds of this variety were sown, therefore only a few bunches of clover were secured. These grew up nicely and continued green until about August 1, when they were checked by hot, dry winds.

A month later most of the roots were apparently dead. Quite recently (December) some of the roots have taken on new life and are coming out nicely. They are at this date not only alive, but have developed new foliage in spite of the freezing weather since the October rains. I desire to make another test of this variety of clover during 1900, and am inclined to think that it will do well here under normal conditions.

VETCHES.

Few of the farmers of Texas are familiar with the vetches. Two varieties were successfully tested during 1899, viz, spring vetch (*Vicia sativa*) and hairy vetch (*Vicia villosa*). Seeds of Stolley vetch (*Vicia leavenworthii*) were sown in February, but the freeze that followed a few days later and continued through the month destroyed them. In the same month seeds of the other two varieties named were sown, but few of them germinated and none of the plants (not vigorous at any time) survived. The later plantings (March 17 and April 10) did well. The spring vetch (*Vicia sativa*) is an annual trailing herb and grew from 18 to 20 inches tall. The hairy vetch has been successfully grown without irrigation in the moist coastal regions of Washington, on the dry prairies of South Dakota, and the rich loamy soils of the Gulf country. Both of these varieties, the spring vetch and the hairy vetch, if sown in Texas in April or May, will be ready for harvest by the middle of August or first of September. Texas farmers are strongly recommended to try both of them. This year seed sown broadcast, in drills, and in hills all gave satisfactory results.

SULLA.

(*Hedysarum coronarium*).

This is a perennial legume, native to southern Italy, that should be known to and cultivated by our Texas farmers. The main plot was planted May 4 and is on the side of a dry, gravelly hill. From the start the growth was vigorous and by the time the hot, dry winds began in July the foliage was from 6 to 12 inches long. The roots penetrated the ground to a considerable depth and up to about August 1 it seemed that this crop was going to stand the drought well. By the 15th of that month, however, it began to show the effects of drought and by September all the foliage was withered and dead. From that time until late in October there was no evidence of vitality in the plants. Following the rain of October 26 the roots revived very quickly and by November 10 the new growth was from 3 to 6 inches tall; since then the roots have been growing down into the earth and the foliage has been pushing up, and the plot is still green. Roots were sent to the Department of Agriculture recently that measured 10 to 14 inches in length with foliage from 5 to 8 inches long. The recent freezes, none of them very severe, however, do not appear to have made any impression either on the roots or foliage. The good showing made by this

forage plant on this upland soil, with the severest drought ever known here, certainly indicates that it may prove of much value in this section. There can be no doubt of its great value in portions of Texas less subject to long, hot, dry spells than this immediate section.

SAINFOIN.

(*Onobrychis satira*).

This plant, known also as esparcette, is a deep-rooting, perennial legume that thrives on dry calcareous soils which are not favorable for either clover or alfalfa. Seeds were sown May 4, and the plants which were from 12 to 18 inches high stood the dry and hot weather better than the vetches, clover, or alfalfa, and quite as well as the sulla. There is no better forage plant for barren hillsides.

COWPEAS.

About sixteen varieties of cowpeas were tested this year, all of them giving satisfactory results. The seed was planted in drills 3 feet apart, and cultivated as long as the season permitted by stirring the surface of the ground between the drills and about the roots. All the plantings were made on the same date, April 11, as there was but little seed of each variety. The plants grew nicely and all matured seed, none of them doing as well as they would have done had the season been more favorable. Seed of each variety was harvested, and will be tried again in 1900. The vines failing on account of the hot, dry winds, were cut and stacked in July, and several bales of excellent hay much relished by cattle and horses were secured.

CANADA FIELD PEA.

Seeds of the Canada field pea were planted April 10, resulting in only a very indifferent stand. The vines grew well, luxuriantly in fact, bloomed well and matured seed abundantly. Both for the vines, which make an excellent forage, and for the seeds, which are quite as rich as the well-known garden pea, which it much resembles in appearance, this variety will doubtless prove of much value to farmers and stockmen in central Texas.

MUMMY PEA.

A few seeds of this variety were planted April 11 in a heavy soil. Only a few germinated. A vigorous growth of vines was secured, but only a few seeds matured.

BLUE PEAS.

A small planting of this variety was made April 11 on the bank of the "dry creek" elsewhere referred to. During the next ten days the rainfall was excessive, the creek overflowed, and most of the vines were destroyed. The few that were left grew luxuriantly but bloomed sparingly, and only a few pods of peas matured.

VELVET BEAN.

The plot of velvet bean in the garden withstood the hot, dry spell of weather better than anything else except the soy bean, up to about August 15, but by September 5 the leaves were drying up and dropping, and by October 1 the plants were mostly dead. The seed was planted in hills about 4 feet apart each way. The vines covered the ground completely and some of them grew to be 10 or 12 feet long. No seed was matured.

SOY BEAN.

The soy bean promises to be one of the best forage plants for this section. Three varieties, early, medium, and late, were tested in the station garden. The early variety grew to be from 8 to 12 inches high and the plants were well filled with pods and seed. The medium variety grew to be from 8 to 12 inches tall and produced a very heavy yield of seed. The late variety proved a vigorous grower. The plants were from 24 to 30 inches high, but they matured only a few beans. This variety did not stand the dry, hot weather quite as well as the velvet bean.

METCALFE BEAN.

(*Phaseolus retusus*.)

A few seeds of the Metcalfe bean were received from the Division of Agrostology and a few from Mr. J. K. Metcalfe, of Silver City, N. Mex. Three plantings were made, March 21, April 11, and April 18, respectively. It was given the best possible chance, in the hope that it would do well in this section. Good stands were secured, and the vines grew nicely, some of them reaching 8 or 10 feet in length. Up to July 1 there was every indication of good results, but very soon after the drought began the vines showed evidence of injury, and by August 1 most of them were either dead or very much dried up.

NATIVE HORSE BEAN.

(*Phaseolus angustissimus*.)

Seed was also received from Mr. Metcalfe of a bean which stockmen here recognized as that known in New Mexico and Arizona as the horse bean. The seeds were planted April 11 and produced only a few plants that grew vigorously and promised good results, but they were injured by drought and produced no blooms, although the vines continued green until early in August. By October 15 they were all dead and the roots did not revive after the rain appeared in the fall.

LENTIL.

From seeds planted April 11 a good stand was secured. The growth was not vigorous, only from 6 to 8 inches tall. Seed formed, but the plot was on the bank of the "dry creek" mentioned, and in an overflow all the plants were destroyed.

SORGHUM.

Several varieties of sorghum were tested in the garden, the non-saccharine as well as the sweeter varieties. All the saccharine varieties did well. The Dhoura corns, Milo maize, Jerusalem corn, "Gyp" corn, Kafir corn, and other varieties of the non-saccharine sorghums all did as well as any reasonable farmer could desire. Satisfactory crops were secured from each of the following varieties: Big Amber, Red Amber, Early Black Amber, and Orange cane; Milo maize, "Gyp" corn, Jerusalem corn, Red Kafir corn, White Kafir corn, White Branching Dhoura corn, and Brown Branching Dhoura corn, all planted April 25. All of the varieties of sorghum tested in central Texas have proved fairly well adapted to the conditions of climate ordinarily prevailing here. They do better during dry years than anything else in the line of grains or forage crops that are cultivated. They, as a rule, yield large crops, and there is no difficulty in curing and preserving them. The idea of baling the hay, noted elsewhere, was to determine if they could be handled successfully in that way. If baling can be practiced they can be grown here to great advantage, and ought to possess considerable commercial value. No richer stock food can be grown in central Texas, and if the hay can be shipped to advantage it will command good prices farther west.

TEOSINTE.

Teosinte was successfully cultivated in the station garden this season. A long season of hot weather and a rich, rather moist, soil are necessary for its full development. One plot of it was in soil that was neither very moist nor very rich, and it made a vigorous growth in spite of the dry weather. It somewhat resembles sorghum in appearance, but has a more branching habit, usually making from 20 to 60 shoots from a single seed and growing from 5 to 10 feet tall. It will prove a valuable forage plant in all parts of this State, to be fed green, as silage or as fodder.

One planting was made April 10, in hills 4 feet apart each way. By July 1 it had met in the rows; but by July 15 the drought had set in, and by August 1 the teosinte had begun to suffer seriously. After that date no seed heads were formed, and those that had previously formed did not develop further. By August 15 the fodder had become yellow and dry, though the roots were still alive. Had a good rain fallen on them even as late as September 1, I am confident they would have revived and put forth a further growth of foliage. However, by October 26, when the drought was broken, even the roots were dead. Early in July some of the stalks were cut, cured, stacked, and later baled. The bales have kept sweet, and those still on hand are all that could reasonably be desired for forage purposes. The stalks are small, the leaves abundant, and the hay is soft. Cattle and horses relish it very much. A yield of 10 to 15 tons per acre can probably be secured here under normal conditions. As the hay is softer and more easily

baled and handled than the sorghums, it will pay farmers and stockmen in central Texas, and in all parts of Texas east and south of this section, to try to grow teosinte for forage.

MILLETS.

Several varieties of millet have been tested in the station garden this year with satisfactory results in each case.

JAPANESE BARNYARD MILLET.

(*Panicum crus-galli.*)

On March 15 seed was sown in rather thin land on a hillside, which had been broken deeply in October, 1898, and not plowed since. A good stand was secured, and by April 18 the millet covered the ground with vigorous growth. On May 11 weeds were abundant and threatened to choke out the millet. June 3 the millet was cut, affording a splendid yield. The new growth started up immediately, and July 1 a second cutting was made—yield rather light. The millet began a third growth, but the drought of July was too severe, and it did not make another crop. The first crop grew to be 3 feet tall and seeded abundantly. Seed sown in another plot April 10 gave quite as satisfactory results. Under normal conditions this variety of millet will probably yield three crops a year.

SHAMA MILLET.

(*Panicum frumentaceum.*)

Seed was planted October 4, 1898, and germinated well, but the winter freezes destroyed all the roots. Other plantings were made March 17 and April 10, 1899. Splendid stands were secured, the growth was vigorous, 18 to 24 inches tall, and the seed development was very good. Several bales of hay were made from the plot, which is equal to the best hay grown or imported into this section. Stock are very fond of it and the yield is good. One cutting only was secured before the drought set in. The second growth gradually dried up during July and August, and by September 1 was to all appearances dead.

PEARL MILLET.

A good stand was secured from seed sown April 18. Some of the stalks grew 7 feet tall with seed heads 8 to 10 inches long. There was an abundance of fodder, which was cut, cured, and baled, making rich soft hay that was relished by stock. It was a success here notwithstanding the drought.

BROOM-CORN MILLET.

Planted in April. The yield was large and the seeds matured before July.

GERMAN MILLET.

This variety has been fully tested here during past years and is justly regarded as of great value.

DWARF ESSEX RAPE.

Seed of this plant was sown April 18. A splendid stand was secured. The growth was vigorous and promised well, but before the conclusion of the experiment the plants were destroyed by prairie dogs.

EXPERIMENTS WITH GRASSES.

Seeds of a large number of varieties of grass were received from the Division during the year. Some were planted October 18, 1898, some in January, 1899, and others early in February, 1899, but on account of the very severe freezing weather that continued through the latter month many of them either failed to germinate or were killed.

SMOOTH BROME.

(*Bromus inermis*.)

This grass has been tested in several of the Southern States and has given good results. Three plantings, all of Russian seed, were made October 4, 1898, November 15, 1899, and April 10, 1899, respectively. The seeds first planted germinated, but the grass was killed down the following February. The results from the other plantings were only partially satisfactory. Fair stands were secured. The growth was rather strong and stood the dry hot weather in July and August reasonably well, but by September 15 it showed the effects of the drought badly. The roots, though still alive, did not revive after the autumn rains began.

SIDE-OATS GRAMA.

(*Bouteloua curtipendula*.)

This is a native grass and the few seeds saved in 1898 were planted April 18, 1899. A good stand was secured, the grass did well, stood the drought well, and the roots revived after the autumn rains began, although the grass is now not green, having cured on the ground as is its habit when growing on the open range. This is one of the most valuable of all the native grasses of central Texas.

BUFFALO GRASS.

(*Bulbilis dactyloides*.)

This grass is frequently mistaken by stockmen for grama grass. It is a native of all this section and furnishes more rich stock feed than any other variety of so-called grama known here. It can be grown successfully from the seed. Land well seeded down to it, along with curly mesquite and needle grass, makes an ideal pasture. Plantings

were made October 4, 1898, January, 1899, and April 18, 1899. Those of October 4 and January gave no results. Some seeds germinated, but the young roots were killed by the following February freeze. The planting of April 18 gave very satisfactory results. A fair stand was secured and the grass stood the drought well. By October 15 the grass had dried up and promised to make good winter pasturage.

OREGON RESCUE GRASS.

(*Bromus unioloides*.)

The few seeds of this variety received were planted May 4 and an excellent stand was secured, although the growth was at no time vigorous. The seed heads began to form when the stalks were 6 to 8 inches tall. By September 1 the grass showed in a marked degree the effect of the hot, dry winds of July and August, and by October 1 the foliage was all dead. The roots did not revive after the autumn rains began, although many of them are still alive.

BERMUDA GRASS.

(*Cynodon dactylon*.)

Sowings were made October 4, 1898, January 8, 1899, March 16, 1899, and April 18, 1899. There were no results from the first two. A few seeds of the March sowing germinated, but the plants soon disappeared entirely. A rather thin stand was secured from the April sowing and the grass grew nicely, continuing green until August, when it showed evidence of suffering on account of the hot, dry winds. By October 1 it had disappeared. The roots did not revive after the autumn rains began, although a few are still alive. This plot is on a rather high point; soil thin and gravelly.

GIANT RYE-GRASS.

(*Elymus condensatus*.)

Seeds of this variety were sown March 15 and April 11. Only a few germinated, and the grass was choked out by weeds.

CANADA RYE-GRASS.

(*Elymus canadensis*.)

This grass was not grown at the station, but an experiment made with it the past season is of interest and demonstrates its value in this section. A small plot of ground outside of the grass station contained this grass, which in the early part of January, 1899, was green and from 4 to 5 inches tall, while nearly all the other varieties of grass in the same neighborhood were dried up and gave no indication of growth. It was arranged with the farmer, who had a lease on the field, to turn

over that small spot for experimentation; it was cleared of brush and the past year's growth of weeds, the surface broken with an iron-tooth harrow, and the soil about the roots loosened. By March 1 there was a splendid growth of grass that kept at least two weeks ahead of any other variety. During June a heavy crop, well headed out and ripe, was cut. A month later a second growth of this wild rye was ready to be cut, and bundles that measured from 20 to 30 inches in length were secured. Later a third crop was cut from the same plot, measuring 15 inches in length, that, when cut, was as green as in springtime, notwithstanding the fact that since October 26 there have been several freezes. During the long, hot, dry spell from early in July to late in October the wild rye-grass gave little evidence of injury from the drought and was about the only grass in this section that continued green. There is no better native hay grass in this section. Stockmen and farmers in all parts of Texas are recommended to secure seeds of wild rye and cultivate the grass for both hay and pasturage. A pasture of 100 acres of it as it is now growing near the station would furnish abundant, rich pasturage for from 30 to 40 head of cows, after having produced two crops of hay during the year.

MEADOW FESCUE.

(*Festuca pratensis*.)

Only one planting was made (November 15), affording a fair stand, and the grass lived through the summer, but by September 1 was to all appearances dead. The roots are still alive, but have made little or no autumn growth.

GRAPEVINE MESQUITE.

(*Panicum obtusum*.)

The sowings of this grass were made March 17 and April 10. Every seed must have germinated, as splendid stands were secured. The seeds were saved by me in 1898. The grass is native to this section of Texas and grows in most of the counties of central Texas. It seems to prefer low, moist ground, but frequently grows luxuriantly on high ground. Both of the plots in the station garden this year were on high land. It has long, creeping, jointed stems that root wherever they touch the ground. The leafage is rather scanty and harsh. The seed is produced abundantly and clings to the stems far into the autumn. The native growth in this section is from 18 to 24 inches in height. Two bales of the cured hay were secured. Stock seem to relish it. None of the grasses grown this year in the station garden resisted the drought more successfully. One plot planted to it was not cut this year and is now covered with the grass, dried up of course, but the roots are alive. It is well worth cultivation for pasture as well as hay.

BALING LEGUMES AND SORGHUMS.

One experiment in baling legumes and sorghums, made this year, is well worth particular mention. The seasons in this section are very favorable as a rule to the development of a vigorous growth of pea and bean vines, although they do not always mature seeds. These vines well cured make rich forage, but as the leaves fall off badly, they have little commercial value. To determine if these crops would bear baling several varieties were secured and planted in the grass garden. They made vigorous growths, and bore heavy crops of peas and beans. When the fruits were nearly full grown, and before they began to turn yellow, the vines were cut and carefully cured as hay. Later a few bales were made of each. Recent examination showed that the hay was as sweet as when first baled. Since very large yields of these legumes can be grown in all parts of Texas nearly every year, the crops can be given a decided commercial value if carefully cured and baled.

A similar experiment was tried with the sorghums and other coarse forage crops, such as teosinte and pearl millet. When the stalks were from 3 to 5 feet tall, and while the seeds were "in the dough," several bundles of each variety were cut, cured, and stacked, and later baled, to determine if they could be handled in that shape to advantage. The bales have kept as sweet as those of the well-recognized hay grasses of this section, and, as in the case of the legumes, the experiment was a decided success.

FAIR EXHIBITS.

In September last an exhibit was made of native and other grasses and forage plants grown during the year. Several boxes of baled hay were prepared for the exhibit at the Paris Exposition in 1900, and 53 bales of excellent hay, each representing a different variety, were made up and turned over to the managers of the district fair held here in October. The exhibit attracted a great deal of favorable attention from farmers and stockmen of this section, who became much interested in the station work. Heretofore many of them have either known nothing of such work or have paid but little attention to it. In the future they will watch the experiments more closely. They are manifesting especial interest in the work intended to improve the range conditions by cultivation of the native pasture grasses.

SUMMARY.

In spite of the adverse conditions under which they have been conducted, the experiments here have yielded results of great value. They have demonstrated the availability of alfalfa (especially oasis alfalfa), sulla, sainfoin, smooth brome, Canada rye grass, Terrell grass, and others for use in permanent pastures and meadows; of the vetches, cowpeas, velvet bean, soy bean, teosinte, and a larger number of varieties of the sorghums and millets for annual or temporary pastures, and

as sources of coarse forage, either fresh or cured; of saltbush for alkali soils; of the gramas, Canada rye grass, grapevine mesquite, curly mesquite, galleta, and needle grass for reseeding the worn out ranges. They have shown the feasibility of range improvement by resting and scarifying the land and by sowing hardy native and introduced grasses. The farmers and ranchmen are beginning to understand that they can, at comparatively small expense, greatly improve their ranges, and by cultivation of the many excellent grasses and forage plants tested this year in the station grounds can add very much to the productive capacity of their ranches and farm pastures. They are beginning to recognize the fact that there are very many native grasses and forage plants that are well worth careful attention and that others of almost, if not quite, equal value are being imported from the semiarid regions of the Old World and can be successfully cultivated here. Many of them propose, during 1900, to test on their own places the different varieties of alfalfa, vetches, sulla, sainfoin, teosinte, saltbush, the saccharine and nonsaccharine sorghums, and the best native and foreign grasses.

Respectfully,

H. L. BENTLEY,

Special Agent, in Charge of Experiments at Abilene, Tex.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *December 30, 1899.*

